EFFECT OF THERMAL AND PLY ORIENTATION ON THE STRUCTURAL PEFORMANCE

THE PAPER PUBLICATION

Arranged as a requirement to complete Undergraduate Study Program in Mechanical Engineering, Engineering Faculty

By:

MUHAMMAD EKA NOVIANTA

D200102006

MECHANICAL ENGINEERING DEPARTMENT

ENGINEERING FACULTY

UNIVERSITAS MUHAMMADIYAH SURAKARTA

2017

VALIDATION SHEET

This final project has been corrected and legalized by supervisor Faculty of Mechanical and Manufacturing Engineering University Tun Hussein onn Malaysia, and knowing by Head of Mechanical Engineering Department, and Secretary of International Program Automotive Engineering, University Muhammadiyah Surakarta :

Name : Muhammad Eka Novianta
NIM : D200102006

Surakarta, 24th July 2017
Admitted by:
Secretary of International Program

(Wijianto, ST.M.Eng.Sc)

I hereby declare that the work in this project report is my own except for quotations and summaries which have been duty acknowledged

Student : .....

MUHAMMAD EKA NOVIANTA

Date : 18 / JUNE / 2017

Supervisor : .....

Dr. AL EMRAN BIN ISMAIL

DECLARATION OF RESEARCH AUTHENTICITY

Through this paper I am assert that the research on end title: **EFFECT OF THERMAL AND PLY ORIENTATION ON THE STRUCTURAL PEFORMANCE** as far as I know there is no plagiarism. All material in the text that referred to the other creations have been enclosed by citation sources and mentioned in references.

If someday, there is any untruth that found in my statement above, I will take responsibility about it.

Surakarta, 24 July 2017

The Writer

MUHAMMAD EKA NOVIANTA

D200102006

EFFECT OF THERMAL AND PLY ORIENTATION ON THE STRUCTURAL PEFORMANCE

[1]Muhammad Eka Novianta

[1]Bachelor Student, Faculty of Mechanical and Manufacturing Engineering, University Tun Hussein onn Malaysia 86400 Parit Raja,Batu Pahat,Johor, Malaysia [2]Mechanical Engineering Universitas Muhammadiyah Surakarta, [3]Faculty of Mechanical and Manufacturing Engineering University Tun Hussein onn Malaysia. muhammadekan@gmail.com

Abstrak

Dalam aplikasi untuk struktur bahan, banyak penyelidikan untuk dapat membangunkan struktur dan bahan-bahan, dengan tegangan - terikan, bahan mulur dan lain-lain. Pengembangan ditujukan untuk bertambah baiknya daripada kenderaan untuk kekuatan bahan, digunakan untuk keselamatan jalanraya, kemalangan industri perlindungan, keselamatan peribadi , dan digunakan untuk pembungkusan bahan makanan industri. Di kawasan yang terdapat masalah biasanya dalam bidang kejuruteraan kaedah unsur terhingga termasuk struktur Analisis bahan itu sendiri, pada peringkat mikro dan analisis struktur yang diperbuat daripada bahan-bahan logam, komposit dan hibrid. Perbandingan 125^{o}C suhu dan spesimen 250^{o}C dengan model ASTM E8 daripada bahan logam untuk kesan orientasi sudut, dari bahan komposit dengan 2 lapis-orientation, 4 lapis-orientation, 6 lapis-orientation dan keluli Hybrid bersalut komposit dengan 2 lapis-orientasi, 4 lapis-orientation, 6 lapis-orientasi. Perbandingan antara semua spesimen dengan kesan kerja suhu pada semua spesimen. Hubungan antara fenomena tegangan-terikan yang bekerja dalam semua spesimen kecuali logam dengan orientasi lapis itu.

Keywords: Lapis-orientasi, Panas daripada suhu bahan, ASTM E8, Keluli Hybrid bersalut Composite.

Abstract

In this application for structure material many research to develop the structures and materials, with stress – strain, impact, ductile materials and etc. In the improving of the vehicles for strength of material, used for highway safety, for protection industrial accidents, personal safety, and used for packaging. In the typical problem areas in engineering finite element method included structural The analysis of the material itself, at the micro level and the analysis of the structure made of metal, composite and hybrid materials. Comparison of thermal 125^{o}C and 250^{o}C specimen with modeling ASTM E8 from metal material to the effect of angle orientation, from composite materials with 2 ply-orientation, 4 ply-orientation, 6 ply-orientation

and Hybrid steel coated composite with 2 ply-orientation, 4 ply-orientation, 6 ply-orientation. The comparisson between all of specimen with the effect of thermal working on the body of all specimens. The relationship between phenomenom stress-strain that work in all specimens except metal with the ply orientation.

Keywords: Ply –orientation, Thermal, ASTM E8, Hybrid Steel coated Composite.

1. INTRODUCTION

The trend of automotive especially to developing in the structural of materials. Composite consists of materials that are made of mixture of two or more materials and has physical properties and mix with different chemicals either in the review in terms of the microscopic and strength of materials. This is very different from the hybrid material. A hybrid material is a mixture or a compound of some materials that are made of metal and then can also be coated with composite or vice versa. Normally this material has a physical and strength of properties materials superior to composite.

Composite materials have been developed several decades ago. In general these composite materials consisting of a merge of the structural fibers and plastic or usually called Fiber Reinforced Plastic (FRP) and typically use fiber such as carbon fiber, fiber glass, basalt fiber, boron fiber or fiber comes from plant result such as flax, wood, banana fiber, coir fiber etc. as for composite produced for commercial purpose, usually using the resin solution, that ingredients of composite the best known is usually epoxy, polyamide, polyester, polypropylene, vinyl ester, etc. Now composite is used in the aerospace industry, automotive industry, household industry, which can be ensuring safety, safe for five to fifteen years or more, because the performance of the composites are excellent with high specific of strength and specific stiffness,method that is for solving problem mathematic and engineering physic. In the typical problem areas in engineering finite element method included structural analysis heat transfer, fluid flow, and potential of electromagnetic. Finite Element Analysis of metal, composite and hybrid materials using software ANSYS WORKBENCH deals with the analysis structure of

materials made from metal, composite and hybrid materials. The analysis of the material itself, at the micro level and the analysis of the structure made of composite materials. The simulation on the software ANSYS can be showed the peformance of stress-strain curve engineering in Metal, Composite and Hybrid specimens.

2. METHODOLOGY

The study intendent to test research that is possitive coleration between comparison the maximum of stress-strain on the Metal specimen, Composite with 2 ply orientation, 4 ply orientation, 6 ply orientation, and Hybrid specimens with 2 ply orientation, 4 ply orientation, 6 ply orientation. All of the specimen using model of ASTM E8. In this case design of the specimens use a model of ASTM E8 for a comparison between model of Metal, Composite and Hybrid.

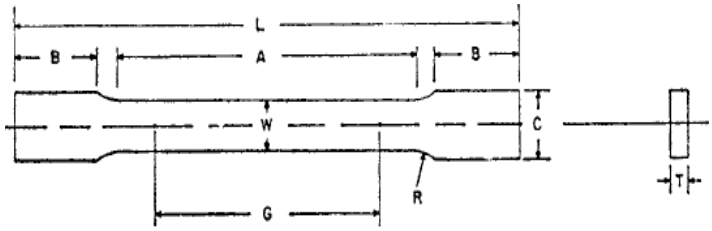

Figure 2. 1: Modeling for Specimens Using ASTM E8 Standard.

Table 2. 1: Size model of specimens.

Name of Selection	Symbol	Dimensions
Gauge length	G	50 mm
Width	W	12.5 mm
Thickness	T	3 mm.
Radius of Fillet	R	65 mm.
Length of reduce parallel section	A	57 mm.
Length of grip section	B	50 mm.
Width of grip section	C	20 mm
Length of specimens	L	210 mm

In this project of simulation by Ansys, and choose materials Steel and Carbon/Epoxy.

Table 2. 2: Properties Material of Steel.

Description	Value	Unit
Unit weight	77	kN/m^3
Density	7.850	Kg/m^3
Thermal Coefficient	$11.7x10^{-6}$	$/^oC$
Modulus of elasticity	200,000	MPa
Poisson Ratio	0.3	

Table 2. 3: Properties Material of Carbon/Epoxy .

Prepreg type	Fibre mass per unit area [g/m^2] (CV [%])	Cured ply thickness [μm]	Fibre volume fraction [%]	Initial Elastic Modulus [GPa] (CV[%])	Tensile strain to failure [%](CV [%])	Compressive strain to failure [%]
TR 30 Carbon\ epoxy	21.2 (4.0)	28.9	41	230	1.5	-

In these variables for the models, research tried to find out performance of stress – strain of the specimens, Effect of different temperatures based on the specimens, to find out the effect of ply orientation and thickness ratio, to comparison of Metal model, Composite models, and Hybrid models. This research have many variable to consider for measurenment and analysis Stress – Strain on the body of specimens.

Table 2. 4: Variable of Model.

Materials	2 Ply orientation	4 Ply Orientation	6 Ply orientation	Temperature	Total Model
Metal Specimen	-	-	-	125°C	1
Composite Specimens	[0/0]; [45/-45]; [90/90]	[0/45/-45/0]; [0/45/45/0]; [0/-45/-45/0]; [0/90/90/0]; [90/45/-45/90]; [90/45/45/90]; [90/-45/-45/90]; [45/-45/-45/45]	[0/90/45/45/90/0]; [0/90/45/-45/90/0]; [0/90/-45/-45/90/0]	125°C	14
Hybrid Specimens	[0/0]; [45/-45]; [90/90]	[0/45/-45/0]; [0/45/45/0]; [0/-45/-45/0]; [0/90/90/0]; [90/45/-45/90]; [90/45/45/90]; [90/-45/-45/90]; [45/-45/-45/45]	[0/90/45/45/90/0]; [0/90/45/-45/90/0]; [0/90/-45/-45/90/0]	125°C	14
Metal Specimen	-	-	-	250°C	1
Composite Specimens	[0/0]; [45/-45]; [90/90]	[0/45/-45/0]; [0/45/45/0]; [0/-45/-45/0]; [0/90/90/0]; [90/45/-45/90]; [90/45/45/90]; [90/-45/-45/90]; [45/-45/-45/45]	[0/90/45/45/90/0]; [0/90/45/-45/90/0]; [0/90/-45/-45/90/0]	250°C	14
Hybrid Specimens	[0/0]; [45/-45]; [90/90]	[0/45/-45/0]; [0/45/45/0]; [0/-45/-45/0]; [0/90/90/0]; [90/45/-45/90]; [90/45/45/90]; [90/-45/-45/90]; [45/-45/-45/45]	[0/90/45/45/90/0]; [0/90/45/-45/90/0]; [0/90/-45/-45/90/0]	250°C	14

The research need to validate data for a program with simulation of the specimen that will be created. Korean Standard (KS) B0810 13 B flat dog- bone

specimen were used for uniaxial monotonic tension test Commercial AZ31B Mg Alloy sheets from POSCO were used with their chemical composition experimental theory from (Nguyen, et.al, 2014), material. *Uniaxial Monotonic Loading Tests.* Generally, heat generation due to dissipation of plastic work related to high strain-rate testing will affect the temperature of the specimen.

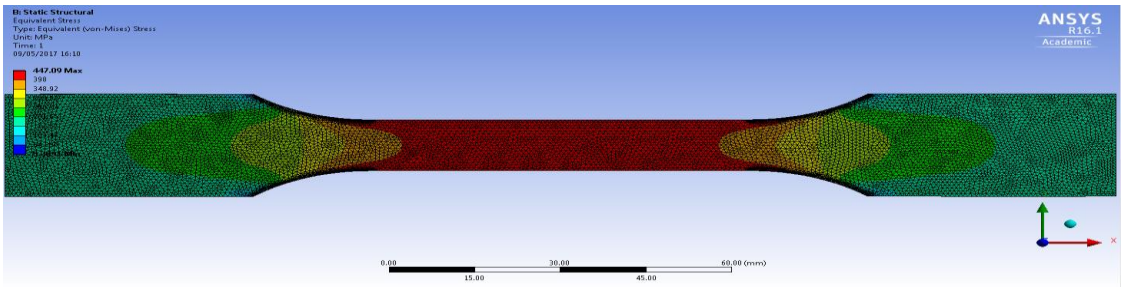

Figure 2. 2: Result of Simulation by software Ansys.

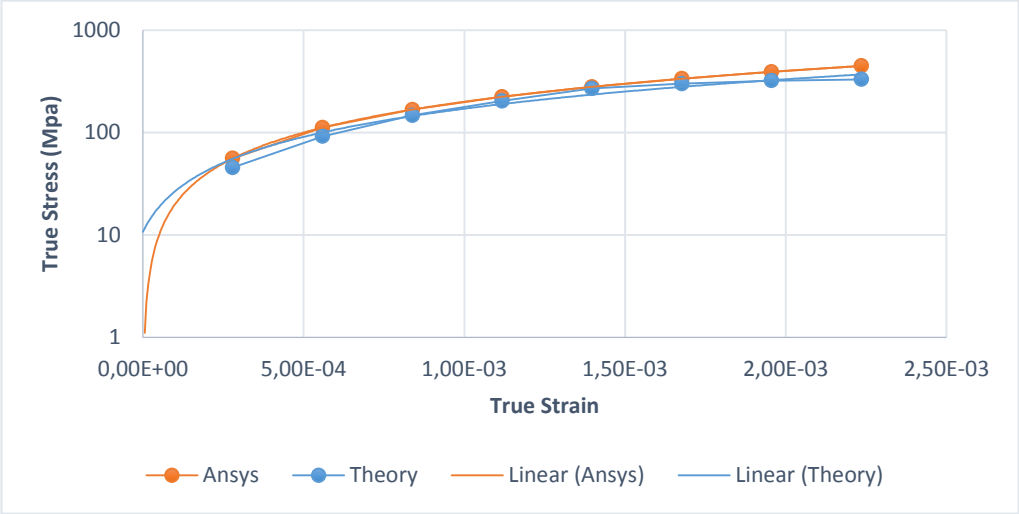

Figure 2. 3: Comparison Result From Ansys and Theory.

In Figure 2.3, it conducted research with a room temperature at 25^{o}C, with the speed of 2 mm/min, with nominal rate of the strain 10^{-3}/s is done with test monotonic uniaxial using magnesium alloy AZ31B. it has been assumed that when the strain rate effect will be eliminated by the time the performance of the test becomes a small with the value of stress is 343.6 MPa. The temperature 25^{o}C,

it works on the specimen. In the Simulation Ansys, the value of stress is 447.09 MPa based on temperature 25^{o}C work on specimen.

3. RESULT AND DISCUSSION

The result from solve and simulation using Ansys Software with comparison of 58 specimens. The specimens of each model have a stress-strain curve and the different of deformation. To discussion of the difference in the magnitude of stress – strain values obtained from each specimens Metal, Composite with 2 Ply-orientation, 4 Ply-orientation, and 6 Ply-orientation, Hybrid with 2 Ply-orientation, 4 Ply-orientation, and 6 Ply-orientation.

3.1 Stress-strain Tensile Test

This is the result of a force acting on the Hybrid model, with 2 ply–orientation and the temperature that works on the most model of the specimens of 125^{o}C.It shown that the phenomena that happen on most of the models at the side edges due to movement on an object when given an opposite force on both.

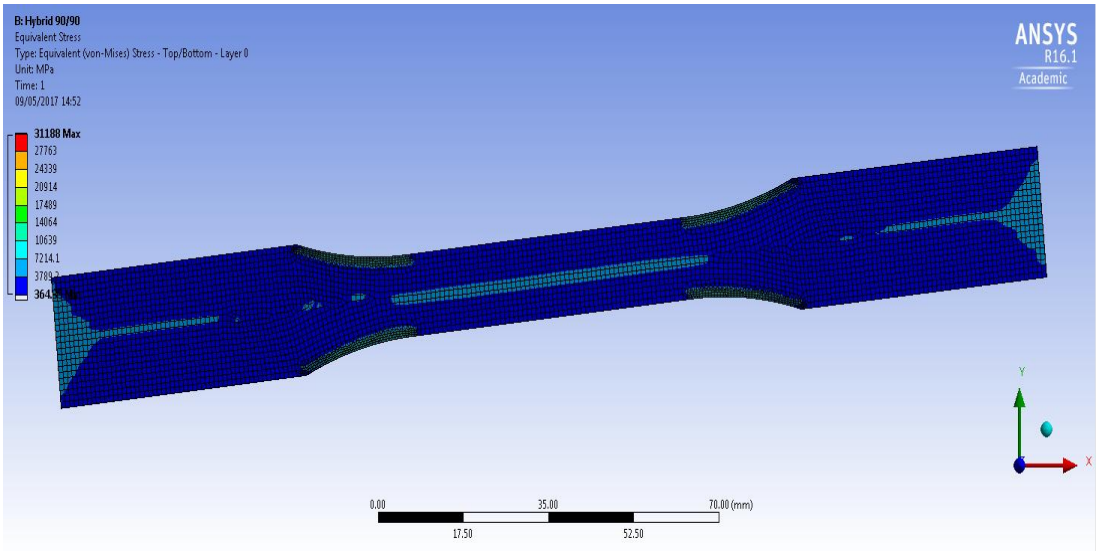

Figure 3.1: Tensile Test von Mises Stress Hybrid Steel coated Composite (2-Ply [90/90]) 125^{o}C.

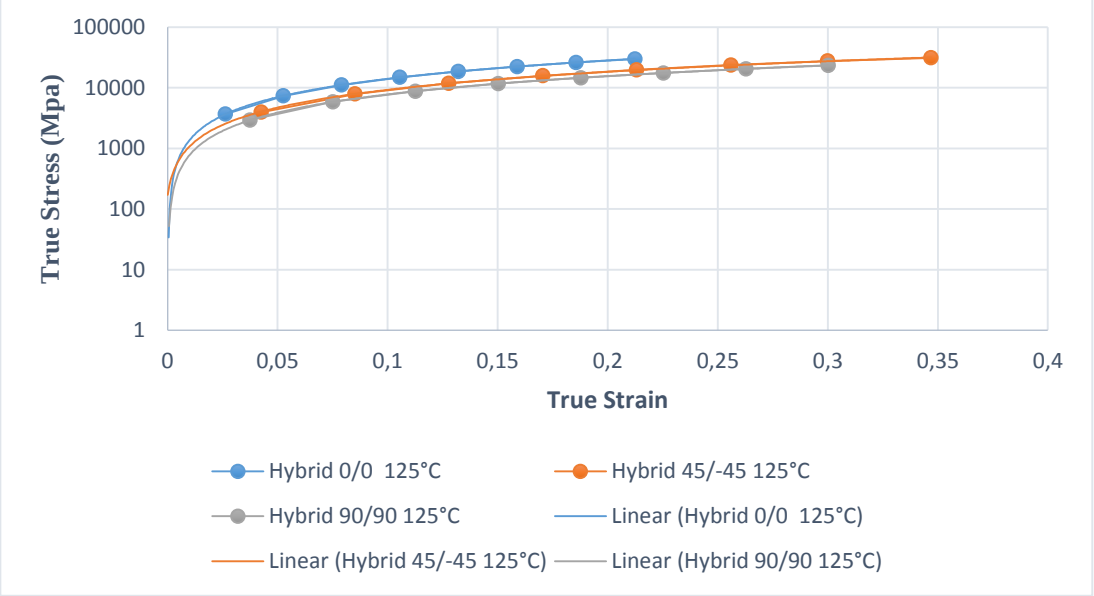

Figure 3.2: Stress- Strain Curve Hybrid Steel Coated Composite 2 Ply-Orientation at temperature 125^{o}C.

In the Figure 3.2 the stress-strain curve of specimen Hybrid Composite 2 Ply-orientation at a temperature of 125^{o}C. The highest value magnitude of maximum stress is Composite [(0/0)] with the value is 29853 MPa and maximum strain is 0.21242 mm.

3.2 Deformation of All Specimens

In this case represented deformation of all specimens and comparison data between the Temperature work on specimens.

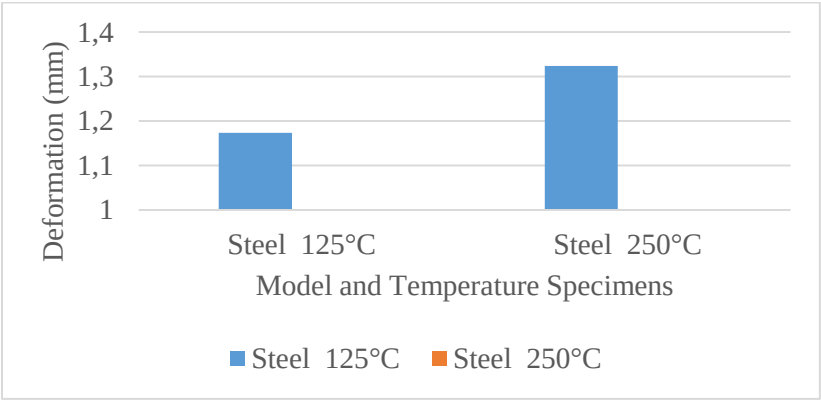

Figure 3.3: Total Deformation of Steel Model Specimens.

In Figure 3.3: Shown, Steel 250^{o}C is increase deformation of specimen. The magnitude is 1.3238 mm. It's different between steel 125^{o}C has value of deformation is 1.1734 mm.

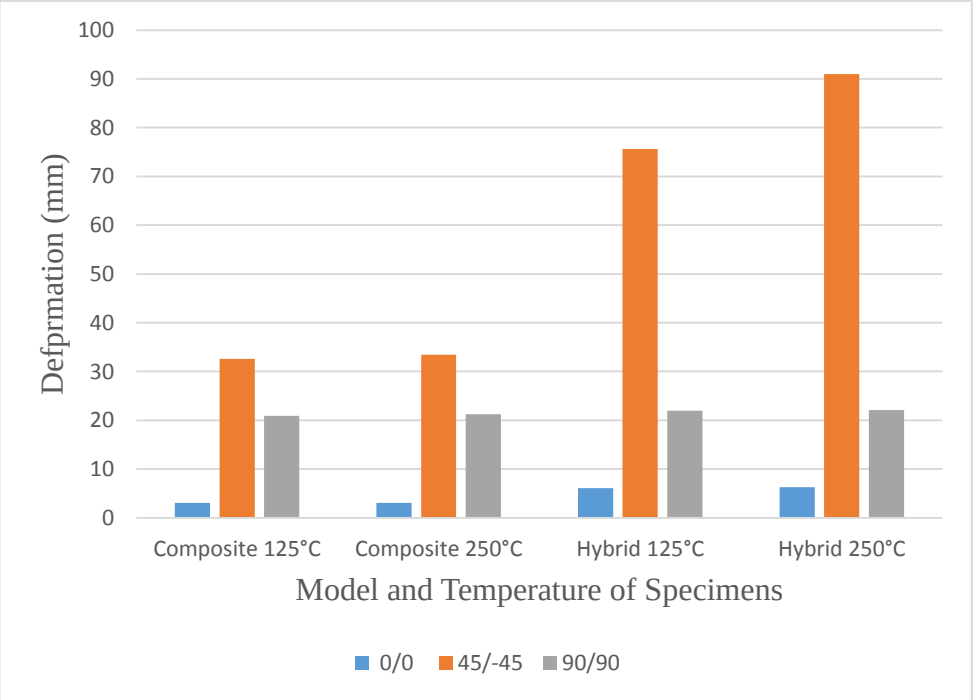

Figure 3.4: Total Deformation of Composite and Hybrid 2 Ply-Orientation Model Specimens.

Shown in Figure 3.4 at temperature 125^{o}C, Composite ply- orientation [(0/0)], is low deformation when compared with Hybrid with ply orientation [(0/0)]. The magnitude of deformation is 3.0599 mm and 6.0661 mm. See on Hybrid with ply orientation [(45/-45)] is highest the magnitude of deformation on the temperature 250^{o}C is 91.007 mm. In Figure 3.5, it shown composite with 4 ply orientation [(90/-45/-45/90)] have the highest value with total deformation 159.58 mm. It states that mixed ply orientation with a value of 45/-45 make these objects become weak. In Figure 3.6 shown that the composite with 6 ply–orientation [(0/90/45/45/90/0)] and [(0/90/-45/-45/90/0)] it have small different value of deformation on temperature 125^{o}C 14.456 mm and 14.37 mm, its same on

temperature 250oC they have small difference value total deformation is 13.825 mm and 13.78 mm.

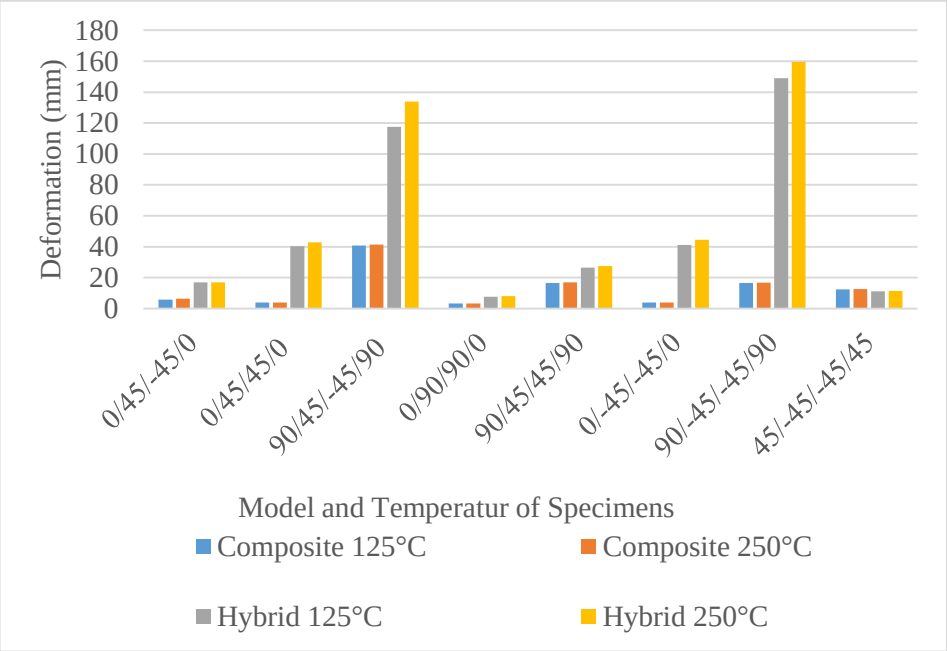

Figure 3.5: Total Deformation of Composite and Hybrid 4 Ply-Orientation Model Specimens.

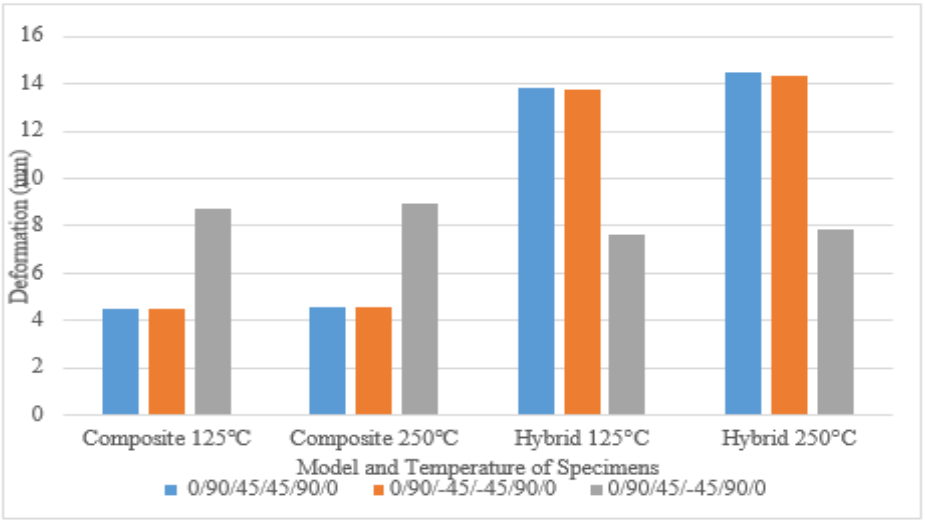

Figure 3.6: Total Deformation of Composite and Hybrid 6 Ply-Orientation Model Specimens.

4. CONCLUSION

The result of simulation on ANSYS Software and discussed with the metal specimen, composite specimens with 2,4,6 ply-orientation, and Hybrid specimens with 2,4,6 ply-orientation on the with temperature 125^{o}C and 250^{o}C work on the body of specimens is observed and consider to theory and the journal that have been read and studied so it can be concluded that:

1. The result of higher of maximum stress is Hybrid (45/-45) with 31416 MPa at temperature 250^{o}C. The influence of thermal based work on the body of specimen, is very influential towards the result of stress-strain in the specimen. The lower of the temperature that work on the body, the result of stress would be decrease and that means is strong materials, but when the higher temperature so the maximum stress-strain work on specimen is getting weak. Shown result of composite on higher temperature, is seems like burned.
2. The application of ply-orientation on the composite and hybrid is very influential towards the value of the stress and strain as well as the strength of these materials. The application of the ply orientation (45/-45), to seen the phenomena occurrence bending on specimen of composite and hybrid with two opposite directions.
3. Modulus of elasticity is a measure for the elasticity of the material. The greater the value this modulus, hence the smaller the elastic strain that occurs at a particular level of imposition, or it can be said that the more rigid material. On the simulation of a steel material at temperature 125^{o}C has a value of E = 2E + 11 (N/m^{2}). The higher the temperature the work on the specimens, then the value of the modulus will be getting smaller.
4. Specimens that applied ply-orientation 45^{o} or -45^{o}, it reduced the strength materials of the specimens. On Hybrid specimen 4 layer 90/-45/-45/90 with temperature 125^{o}Cdan 250^{o}C undergoes very large deformation

159.58 mm and 148.95 mm when compared with some other model specimens. This suggests that the influence of ply-orientation is applied in a mixture of this material effect to the lack of strength of the specimen. While most small deformation value experienced by steel at 125^{o}C temperature is 12.506 mm.

ACKNOWLEDGEMENT

Bismillahirrahmanirrahim. All Praises and thanks to Allah who gives me Mercy and Blessing to complete this final project. My appreciations are firstly dedicated to my Supervisor Dr. Al Emran Ismail who always take care to me and give me spirit to complete this thesis. Secondly, thanks to, Dr Kamarul Azhar Kamarudin, and En. Muhamad Khairudin Awang who always guide me patiently.

REFERENCES

Baghaei, Behnaz, Mikael Skrifvars, and Lena Berglin. "Characterization of thermoplastic natural fibre composites made from woven hybrid yarn prepregs with different weave pattern." Composites Part A: Applied Science and Manufacturing 76 (2015): 154-161.

Rosni Binti Yusoff, Hitoshi Takagi, Antonio Norio Nakagaito, Tensile and flexural properties of polylactic acid-based hybrid green composites reinforced by kenaf, bamboo and coir fibers, Industrial Crops and Products, Volume 94, 30 December 2016, Pages 562-573.

L.L. Hütsch, J. Hütsch, K. Herzberg, J.F. dos Santos, N. Huber, Increased room temperature formability of Mg AZ31 by high speed Friction Stir Processing, Materials & Design (1980-2015), Volume 54, February 2014, Pages 980-988.

M. GuruRaja and A. HariRao, "Influence of Angle Ply Orientation on Tensile Properties of Carbon/Glass Hybrid Composite," Journal of

Minerals and Materials Characterization and Engineering, Vol. 1 No. 5, 2013, pp. 231-235.

Budhoo Y., Delale F., Liaw B. (2011) Temperature Effect on Tensile Testing of Hybrid and Non-Hybrid Composites. In: Proulx T. (eds) Experimental and Applied Mechanics, Volume 6.Conference Proceedings of the Society for Experimental Mechanics Series. Springer, New York, NY.

Shenoy, Srinivas, et al. "Interlaminar shear and flexural properties of E-glass/jute reinforced polymer matrix Composites." (2015): 26-31.

Gebhardt C. Praxisbuch FEM mit ANSYS Workbench: Einführung in die lineare und nichtlineare Mechanik. München: Hanser; 2011.

Krishna, K. Phani, and Y. Vinod Kumar. "Mechanical Properties of Hybrid Fiber Reinforced Concrete and Cement Partially Replaced with Ggbs." cellulose 43 (2016): 4.

Seo, Dong-Woo, et al. "Evaluation for tensile performance of recently developed FRP hybrid bars." International Journal of Emerging Technology and Advanced Engineering 4.6 (2014): 631-637.

Al-Mosawi, Ali I., Shaymaa Abbas Abdulsada, and Muslim M. Ali. "Ansys modeling for estimation Tensile and flexural strength of green composite." (2016).

Xianming Shi, Guoxiang Zhou, Anburaj Muthumani, Corrosion of metals exposed to 25% magnesium chloride solution and tensile stress: Field and laboratory studies, Case Studies in Construction Materials, Volume 7, December 2017, Pages 1-14

S. B. Jamaludin, M. H. Abdullah, M. N. Mazlee, K. Hussin, "Effect of Solution Treatment Temperature on Tensile Strength of Al-Mg-Si Alloy", Materials Science Forum, Vol. 819, pp. 39-44, 2015

Valentina Di Maria, Luca D'Andria, Giovanni Muciaccia, Anton Ianakiev, Influence of elevated temperature on glued-in steel rods for timber elements, Construction and Building Materials, Volume 147, 30 August 2017, Pages 457-465.

Majzoobi, Gholam-Hossain, et al. "A new approach for the correction of stress–strain curves after necking in metals." The Journal of Strain Analysis for Engineering Design 50.2 (2015): 125-137.

Jacopo Donnini, Francisco De Caso y Basalo, Valeria Corinaldesi, Giovanni Lancioni, Antonio Nanni, Fabric-reinforced cementitious matrix behavior at high-temperature: Experimental and numerical results, Composites Part B: Engineering, Volume 108, 1 January 2017, Pages 108-121.

Nguyen, Ngoc-Trung, et al. "Mechanical behavior of AZ31B Mg alloy sheets under monotonic and cyclic loadings at room and moderately elevated temperatures." Materials 7.2 (2014): 1271-1295.